Remarks

Applicants respectfully request reconsideration of the present patent application in view of the above-amendment and following remarks. The specification and claims 1, 10 and 15 have been amended. No claims have been added or cancelled. Therefore, claims 1-19 are pending in the present application.

The specification has been amended to correct a typographical error in identifying the symbol for Celsius. Claims 1, 10 and 15 have been amended to change "a starting temperature" to "said starting temperature" in step f) since the starting temperature was first introduced in the preamble of each claim. It is requested that the above-reference amendments be entered.

Claims 6 and 7 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2002/0071974 to Yamaoka ("the Yamaoka reference"). Applicants respectfully traverse this rejection.

Independent claim 6 is directed to a catalytic hydrocarbon reformer for making reformate, comprising: an electronic control module for controlling the flow of hydrocarbon fuel and air into the reformer. The electronic control module is programmed with a software construct for determining a fuel combustion time interval for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature. The fuel combustion time interval is at least dependent on a starting temperature of a catalyst in the reformer.

Applicants maintain that the Yamaoka reference does not teach or suggest a catalytic hydrocarbon reformer including an electronic control module that is programmed with a software construct for determining a fuel combustion time

interval for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature, wherein the fuel combustion time interval is at least dependent on a starting temperature of a catalyst in the reformer as recited in claim 6. In the Office Action, the Examiner acknowledges that the Yamaoka reference does not explicitly disclose determining a fuel combustion time interval for pre-heating the reformer (4). *See Office Action mailed on March 30, 2009 ("Office Action")*, pg. 6, ¶ 13. However, the Examiner concluded that "it would have been obvious to one having ordinary skill in the art at the time of the invention to *measure* the time necessary [for] heating the catalyst to a reformer temperature . . . ." *Id.* (emphasis added). Applicants would like to first point out that the invention set forth in claim 6 does not relate to *measuring* a fuel combustion time interval for pre-heating the reformer, as asserted by the Examiner, but is instead uses a *software construct* that is dependent at least in part on a starting temperature of a reformer catalyst to determine the fuel combustion time interval.

The specification of the present patent application recognizes that one approach for determining the fuel combustion time interval is to empirically calculate the amount of time it would take for the surface of the catalyst to reach a minimum reforming temperature. *See Specification*, pg. 2, lines 13-15. However, empirically determining the fuel combustion time interval does not take into account the temperature of the catalyst upon start-up, and therefore the empirical calculation would be inaccurate if the catalyst is still warm from a previous period of operation. *See id.* at lines 16-20.

According to the Examiner, it would have been obvious to one having ordinary skill in the art at the time of the invention to measure the time necessary for heating the catalyst to a reformer temperature because the Yamaoka reference discloses a target temperature setting means, a quantity determinator, measuring time, and the importance of the catalyst temperature. *See Office Action*, pg. 6, ¶ 13. While each of these four aspects mentioned by the Examiner are referred to in the Yamaoka reference, Applicants submit that none of them relate to the determination of a fuel combustion time interval for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature based in part on the starting temperature of the reformer catalyst.

The "temperature setting means" and the "quantity determinator" are generally described in paragraphs [0010], [0011], and [0015] of the Yamaoka reference. Paragraph [0010] of the Yamaoka reference states that a heating device (3) is used to heat raw fuel (11) to a predetermined target temperature, and a raw fuel quantity determinator is used to determine the amount of raw fuel (11) that is supplied to the heating device (3). *See Yamaoka*, ¶ [0010]; FIG. 8. Further, paragraph [0010] of the Yamaoka reference states that a target temperature setting means operates to set the target temperature of the raw fuel (11) on the basis of the quantity of the raw fuel (11) that is supplied to the heating device (3). *See id.* The Yamaoka reference also states that if the quantity of the raw fuel (11) supplied to the heating device (3) increases, the target temperature for the raw fuel (11) also increases. *See id.* at ¶ [0011]; *see also* ¶ [0043] (stating that the quantity of the raw fuel passing through the heating device is dependent upon the load of the fuel cell).

It is also disclosed that the quantity of raw fuel (11) fed to the heating device (3) is based on the load applied to the fuel cell (1). *See id.* at ¶ [0044].

In view of the above, Applicants submit that the "target temperature setting means" and the "quantity determinator" mentioned by the Examiner in the Office Action do not relate to a fuel combustion time interval that is dependent on a starting temperature of a catalyst within the reformer as recited in claim 6. As mentioned above, the quantity determinator determines the quantity of raw fuel flowing through the heating device (which is dependent upon the load applied to the fuel cell), and the target temperature setting means sets the target temperature of the raw fuel within the heating device based on the determined quantity of raw fuel. Neither of these components within the Yamaoka reference relates to a starting temperature of a catalyst within the reformer.

Paragraph [0015] of the Yamaoka reference relates to a detector for detecting a physical value indicating the quantity of the raw fuel heated by the heating device, and a correcting means for correcting the target temperature based on the physical value detected by the detector. *See Yamaoka*, ¶¶ [0014], [0015]. Neither the raw fuel quantity detector nor the correcting means have anything to do with determining a fuel combustion time interval that is dependent upon a starting temperature of a catalyst within the reformer, as set forth in claim 6. The detector merely operates to measure the actual quantity of raw fuel passing through the heating device, which is turn dependent upon a load applied to the fuel cell (1), not to the starting temperature of a catalyst within the reformer. The correcting means adjusts the

target temperature for the raw fuel based on the actual measured value, which also does not relate to the starting temperature of a catalyst within the reformer.

The Examiner also notes that time is measured in FIG. 6 of the Yamaoka reference in support of the position that it would have been obvious to one having ordinary skill in the art at the time of the invention to measure the time necessary for heating the catalyst to a reformer temperature. *See Office Action*, pg. 6, ¶ 13. The two graphs shown in FIG. 6 of the Yamaoka reference do not suggest a fuel combustion time interval for pre-heating a hydrocarbon catalytic reformer. Instead, FIG. 6 discloses "a correction value of a quantity of fuel for burning at a transient time when a quantity of raw fuel changes as a step function." *Yamaoka*, ¶ [0023]. In other words, the graphs in FIG. 6 of the Yamaoka reference relate to a circumstance where the amount of raw fuel passing through the vaporizing device (7) increases due to, for instance, an increase in load applied to the fuel cell. *See id.* at ¶ [0043]. Given the increased flow of raw fuel passing through the vaporizing device (7), the target temperature of the raw fuel will also increase. *See id.* at ¶¶ [0010], [0011]. In order to increase the temperature of the raw fuel flowing through the vaporizing device (7), the amount of raw fuel injected into the burning device (6) will also need to be increased. *See id.* at ¶ [0027]. The graphs shown in FIG. 6 of the Yamaoka reference relate to introducing a correction value of raw fuel for burning in the burning device (6) as the quantity of raw fuel passing through the vaporizing device (7) changes. The fuel flow is typically represented as a quantity of fuel per unit of time. The Examiner has not provided any explanation of how the time component for the rate of fuel flow relates to the determination of a fuel combustion time interval

for pre-heating the hydrocarbon catalytic reformer to a minimum reforming temperature.

In rejecting claim 6, the Examiner also takes into account the discussion in paragraph [0002] of the Yamaoka reference relating to the importance of a minimum activation temperature for a reformer catalyst. *See Office Action*, pg. 2, ¶ 2; pg. 6, ¶ [0013]. Applicants do not dispute that it is known to heat a reformer catalyst to a minimum reforming temperature before reforming can begin. In fact, the background of the invention section of the present patent application acknowledges this on page 2, lines 22-23. The present patent application also goes on to state that it is of great importance to know when the catalyst surface reaches a temperature sufficient to support catalysis so that the fuel:air ratio may be switched from a fuel-lean mixture to a fuel-rich mixture, otherwise the fuel cell system will be subject to reduced efficiency and durability. *See id.* at pg. 1, line 28 through pg. 2, line 5. Therefore, the discussion in paragraph [0002] of the Yamaoka reference discloses nothing more than what has already been addressed in the background of the invention section of the present patent application.

It is relevant to note that the invention set forth in claim 6 is not only directed to pre-heating the hydrocarbon catalytic reformer to a minimum temperature, but further focuses on a method of determining how long to pre-heat the reformer catalyst. In the background of the invention section of the present patent application, three methods of determining when the catalyst has reached a minimum temperature are discussed. *See Specification*, pg. 2, lines 6-24. One method is to use a temperature sensor on the catalyst surface and waiting for it to indicate that a

minimum reforming temperature has been reached. *See id.* at pg. 2, lines 6-9. Another method would be to dispose a temperature probe within the ceramic elements of the reformer. *See id.* at pg. 2, lines 9-12. Yet another approach may be to empirically calculate the amount of time it would take for the surface of the catalyst to reach a minimum reforming temperature. *See id.* at pg. 2, lines 13-15. All of these known methods suffer from some type of drawback as noted in the present patent application, which are addressed using the method in accordance claim 6. *See id.* The discussion in paragraph [0002] of the Yamaoka reference does nothing more than disclose what was presented in the background of the invention section of the present patent application, and does not eliminate the possibility that the Yamaoka reference utilizes the same prior art methods of determining when the catalyst has reached a minimum temperature that were discussed in the background of the invention section of the present patent application. *See Specification*, pg. 2, lines 6-24.

In the Office Action, the examiner also made reference to paragraph [0050] of the Yamaoka reference in support of the rejection of claim 6. *See Office Action*, pg. 2, ¶ 2. Paragraph [0050] of the Yamaoka reference relates to controlling the temperature of the raw fuel vapor being sent to the reforming catalyst using the air flow (10). It is further mentioned in paragraph [0050] that the temperature of the raw fuel vapor, if too high, may have a negative affect on the reformate catalyst. This discussion in paragraph [0050] of the Yamaoka reference discloses nothing more than what is set forth in the background of the invention section of the present patent application. *See Specification*, pg. 1, line 22 through pg. 2, line 24. There is nothing

disclosed in this portion of the Yamaoka reference that indicates that a starting temperature of the reformer catalyst is used to determine how long to pre-heat the hydrocarbon catalytic reformer so it reaches its minimum reforming temperature. The only temperature mentioned in paragraph [0050] of the Yamaoka reference that relates to the reformer catalyst is its activation temperature, not a starting temperature.

For at least the reasons set forth above, Applicants submit that there has been no evidence to conclude that the Yamaoka reference discloses a fuel combustion time interval that is dependent upon a starting temperature of a catalyst within the reformer. As such, a prima facie case of obviousness has not been established based on the Yamaoka reference. Applicants request that the rejection of claim 6 be withdrawn. As claim 7 depends from claim 6, it is requested that the rejection of claim 7 be withdrawn as well.

Claims 1-5 and 10-19 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent Publication No. 2003/0101713 to Dalla Betta ("the Dalla reference") in view of the Yamaoka reference.

Independent claim 1 is directed to a method for pre-heating a hydrocarbon catalytic reformer from a starting temperature to a minimum reforming temperature utilizing an electronic control module, comprising the steps of: a) selecting a fuel type to be combusted; b) determining the latent heat of combustion of the selected fuel type; c) selecting a flow rate of the combustion fuel; d) determining the heat capacity of a catalyst to be heated in the catalytic reformer; e) determining a mass of the reformer to be heated; f) determining a starting temperature of the catalyst in the

catalytic reformer; g) utilizing a software construct to produce the fuel combustion time interval, wherein the construct utilizes the latent heat of combustion, the selected combustion fuel flow rate, the heat capacity of the catalyst, the mass to be heated, and the starting temperature; and h) pre-heating the hydrocarbon catalytic reformer using a combustor for the fuel combustion time interval so that the hydrocarbon catalytic reformer reaches the minimum reforming temperature.

Applicants maintain that the combination of the Dalla reference and the Yamaoka reference do not teach or suggest a method for pre-heating a hydrocarbon catalytic reformer comprising the steps of: f) determining a starting temperature of a catalyst in a catalytic reformer; and g) utilizing a software construct to produce a fuel combustion time interval based on, among other factors, the starting temperature of the catalyst of the catalytic reformer as recited in amended claim 1. In rejecting claim 1, the Examiner stated that the Dalla reference discloses the use of fuel type, flow rate, catalyst mass, heat of combustion, and initial temperature of the catalyst and other system constraints for determining the length of time for preheating the reformer catalyst to a minimum reforming temperature. *See Office Action*, pg. 4, ¶ 8. In support of this statement, the Examiner made reference to paragraphs [0052], [0078], [0101], and [0105] of the Dalla reference. *See id.* Applicants submit that none of the cited paragraphs, taken alone or in combination, suggest that a starting temperature of a catalytic reformer is used in a software construct to produce a fuel combustion time interval for pre-heating a catalytic reformer.

Paragraph [0052] of the Dalla reference states in part that "the fuel may be preheated so that it is more readily vaporized upon injection." Therefore, this portion

of the Dalla reference refers to preheating the *fuel* so that it is readily vaporized upon injection into the reformer, and is not directed to preheating the *reformer catalyst* to a minimum reformer temperature, as implied by the Examiner.

Paragraph [0078] of the Dalla reference states in part that the catalytic reformer may include a thermal mass, a high heat capacity, and a low pressure drop. There is nothing disclosed in this paragraph of the Dalla reference that provides the basis for concluding that a starting temperature of a catalytic reformer is used in a software construct to produce a fuel combustion time interval for pre-heating a catalytic reformer.

In regard to paragraph [0101], the Examiner pointed out that the Dalla reference discloses that system variables such as the "length of time the fuel processor is operated in rich mode" can be determined. *See Office Action*, pg. 4, ¶ 8; *Dalla*, ¶ [0101]. Applicants maintain that the fuel processing referred to in paragraph [0101] is not related to the length of time that the fuel is combusted to heat the reformer (i.e., fuel combustion time interval for pre-heating the catalyst), but is instead related to the length of time the fuel processor (i.e., reformer) is operated in a "rich mode," which relates to a reforming mode (occurring after pre-heating the catalyst). *See Specification*, pg. 1, lines 26-28 (stating that a reformer operates in a fuel rich condition and a combustor operates in a lean fuel to air ratio). Paragraph [0101] does not provide any evidence to conclude that a starting temperature of the catalyst in the fuel processor (i.e., reformer) is taken into consideration when determining how long to use a combustor to pre-heat the reformer to a minimum reforming temperature.

The Examiner also made reference to paragraph [0105] of the Dalla reference in support of the rejection of claim 1. *See Office Action*, pg. 3, ¶ 3; pg. 4, ¶ 8. In particular, paragraph [0105] states in part that the "fuel was combusted on the catalyst and the catalyst temperature rose rapidly as shown by the temperature of the three thermocouples in FIG. 8B." *Dalla*, ¶ [0105]. This portion of the Dalla reference does not disclose how the system disclosed therein determines how long to pre-heat the reformer catalyst so that the reformer catalyst reaches a minimum reforming temperature, and also does not disclose whether or not a starting temperature of the reformer catalyst is used to make the determination. The Examiner appears to be taking the position that since the starting temperature of the gas at the outlet of the reformer catalyst is shown in the graph in FIG. 8B of the Dalla reference, these starting temperatures are used in a software construct to determine a fuel combustion time interval for pre-heating the reformer catalyst. Applicants submit that such a suggestion is not provided in the Dalla reference. Just because the temperature of the gas at the outlet of the reformer are shown in a graph does not mean that a software construct utilizes the starting temperature to calculate a pre-heat fuel combustion time interval.

The Examiner makes further reference to paragraphs [0055], [0064] and FIG. 4 of the Dalla reference in rejecting claim 1. *See Office Action*, pgs. 2-3, ¶ 3. Specifically, the Examiner stated that the Dalla reference "explicitly discloses the measuring, compensating for, and changing of the catalyst temperature for the reformation/combustion process." While the temperature of the catalyst may be measured for the purpose of the warm-up and reformation process, Applicants

submit that it is possible the Dalla reference is simply using the prior art methods of determining when the catalyst has reached a minimum temperature that were discussed in the background of the invention section of the present patent application. *See Specification*, pg. 2, lines 6-24; *see also supra* at pgs. 15-16. For instance, the Dalla reference could monitor the temperature of the gas at the outlet of the reformer taken by the three thermocouples described in paragraph [0105], wait for the temperature readings to reach the minimum reforming temperature, and then cease the pre-heating phase; this method is similar to the methods described in the background of the invention section of the present patent application, which is dissimilar to the method disclosed in claim 1. *See Specification*, pg. 2, lines 6-12. There is nothing in the Dalla reference to suggest that a software construct is being used to produce a fuel combustion time interval based on, among other factors, the starting temperature of the catalyst of the catalytic reformer.

In rejecting claim 1, the Examiner acknowledges that the Dalla reference does not disclose the details of the software construct set forth in step g) of claim 1, and therefore combines the Yamaoka reference with the Dalla reference. *See Office Action*, pg. 4. Applicants submit that the Yamaoka reference fails to teach or suggest the step recited in step g) of claim 1 for at least the same reasons that were set forth above with respect to claim 6.

The Examiner also states that "it would have been obvious to one having ordinary skill in the art at the time of invention to measure the time necessary heating the raw fuel to a reformer temperature in Dalla Betta using the computer of Yamaoka to compensate for the time necessary for the process to occur given the

quantity of fuel used and target temperature desired via Yamaoka." *Office Action*, pg. 5, ¶ 9.

Given that the Examiner's statement set forth above is specifically directed to measuring the "time necessary [to heat] the raw fuel to a reformer temperature," it appears that the Examiner is misinterpreting the language of claim 1. The language of claim 1 does not relate to determining how long it will take to heat the raw fuel to a reforming temperature, but instead relates to determining the amount of time that combustion must take place in order to pre-heat the catalytic reformer to a minimum reforming temperature. The amount of time that it will take to heat the raw fuel to a reforming temperature does not necessarily correlate to the amount of the time it will take for the catalytic reformer to reach a minimum reforming temperature. The time intervals for heating the raw fuel compared to heating the catalytic reformer may be based on independent factors. For example, the composition of the raw fuel and the reformer catalyst are different and therefore will heat up at different rates. In addition, the starting temperatures of the reformer catalyst and the raw fuel prior to heating may be different. Therefore, Applicants submit that a time interval for heating raw fuel to a reformer temperature, as proposed by the Examiner, is not equivalent to a fuel combustion time interval for pre-heating a catalytic reformer to a minimum reforming temperature as set forth in claim 1.

For at least the foregoing reasons, Applicants submit that the proposed combination of references fails to teach or suggest all of the limitations included in claim 1, and therefore a prima facie case of obviousness has not been established with respect to claim 1. As such, Applicants request that the rejection of claim 1 be

withdrawn. As claims 2-5 depend from claim 1, these claims are not taught or suggested by the combination of the Dalla and Yamaoka references for at least the same reasons that were set forth with respect to claim 1.

Since claims 10-19 also include limitations that are similar to those that were argued above with respect to claim 1, Applicants submit that claims 10-19 are not taught or suggested by the combination of the Dalla and Yamaoka references for at least the same reasons that were set forth with respect to claim 1. It is requested that the rejection of claims 10-19 be withdrawn.

Claim 8 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Yamaoka reference in view of the Dalla reference. Since claim 8 depends from claim 6, Applicants submit that the Yamaoka reference fails to teach or suggest all of the limitations included therein for at least the same reasons that were set forth above with respect to claim 6. The Dalla reference also fails to teach or suggest the limitation that was lacking in the Yamaoka reference. It is therefore requested that the rejection of claim 8 be withdrawn.

Claim 9 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over the Yamaoka reference in view of U.S. Patent Publication No. 2002/0150532 to Grieve ("the Grieve reference"). Since claim 8 depends from claim 6, Applicants submit that the Yamaoka reference fails to teach or suggest all of the limitations included therein for at least the same reasons that were set forth above with respect to claim 6. The Grieve reference also fails to teach or suggest the limitation that was lacking in the Yamaoka reference. It is therefore requested that the rejection of claim 8 be withdrawn.

Conclusion

In light of the foregoing, Applicants submit that claims 1-19 are in condition for allowance and such allowance is respectfully requested. Should the Examiner feel that any unresolved issues remain in this case, the undersigned may be contacted at the telephone number listed below to arrange for an issue resolving conference.

Applicants do not believe that any fee is due at this time. However, the Commissioner is hereby authorized to charge any fees that may have been overlooked to Deposit Account No. 50-4635.

Respectfully submitted,

Dated: 6/1/2009

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RECEIVED IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

DATE: June 1, 2009 DOCKET: DE258-67018/DP-310836
APPLICANT: Kevin R. Keegan, et al
SERIAL NO.: 10/801,740
FILED: 03/16/2004
FOR: REFORMER START-UP STRATEGY FOR USE IN A SOLID OXIDE FUEL CELL CONTROL SYSTEM

PAPERS ENCLOSED: Transmittal Form (1 page); Amendment and Response to Final Office Action (24 pages); Certificate of Mailing by First Class Mail for the above; Return Receipt Postcards (2).

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